Mapping the pathways between recreational cannabis use and mood disorders

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Abstract

Issues Addressed: Although cannabis use is still illegal in most places around the world, it remains a widely used drug. The recreational use of cannabis has been linked to multiple mental wellbeing issues, including psychosis, depression, and anxiety. The objective of this study was to investigate the temporal dynamics of cannabis use in relation to mental health issues.

Methods: The current research uses a novel methodological approach, Behaviour Sequence Analysis, to understand the temporal relationship between recreational cannabis use and surrounding issues related to mental wellbeing, in a sample of 61 participants who had written autobiographical accounts online.

Results: The results indicated a bi-directional temporal ordering between cannabis use and mood disorders. Cannabis use preceded psychosis, and can also exacerbate symptoms of psychosis, depression, and anxiety. Findings also suggested that low self-esteem may be a predictor of future cannabis use.

Conclusions: Research shows a link between mood disorders and recreational cannabis use. The BSA method can be used in applied settings to map pathways in individuals' life histories.

So what?: The current study shows that the sequential links between cannabis use and psychosis, depression and anxiety. Results show there is no single clear pathway and clinical practitioners should focus on a wider range of factors in individual's case histories.

Keywords: cannabis; drugs; psychosis; depression; anxiety; Behaviour Sequence Analysis

Summary

The relationship between cannabis use, psychosis, depression, and anxiety are outlined in the current study using a novel research method in Health Promotion. Results indicate bi-directional pathways between recreational cannabis use and psychosis, which are shown in easy-to-understand flow diagrams. These findings can be used in health promotion education.

Mapping the pathways between recreational cannabis use and mood disorders: A Behaviour Sequence Analysis approach

The relationship between recreational cannabis use and mood disorders is a contentious issue, and widely debated in public forums, the media, and academia (1,2). In January 2009, cannabis was re-classified as a Class B drug under the Misuse of Drugs Act, 1971 (3), which means that there are serious consequences for those found in possession of cannabis. However, the criminal charges have not prevented people from using cannabis recreationally, as there is strong evidence that cannabis use is becoming more common in the United Kingdom, with 2.1 million people having used it in 2015 (data taken from Home Office, 2016 Drug Misuse report). With the increase in cannabis use, there has been much debate about the use of cannabis as a treatment for illnesses (4,5) as well as whether cannabis should be used recreationally (6). Recreational cannabis has been linked to several psychiatric conditions: psychosis, depression, and anxiety (7,8). Despite this, research exploring how cannabis affects disorders such as depression and anxiety have had varied results (9,10) and many studies have concluded that it is unclear whether cannabis use leads to mood disorders or if mood disorders lead to cannabis use (11). The aim of the present study was to investigate patterns of behaviour regarding recreational cannabis use and mental wellbeing. Due to the complex nature of social processes and behaviours, methods that describe simple one-directional relationships are unlikely to explain relationships between multiple variables. Therefore, a novel method, Behaviour Sequence Analysis (BSA), was used, as it can clearly outline multiple, bi-directional pathways (25).

Cannabis use and Psychosis

Psychosis is a functionally disruptive symptom of many psychiatric conditions. Early definitions related it to impairments in reality testing and/or loss of ego boundaries (APA, DSM-II). More recently, the definition has been developed to include hallucinations and delusions. Research over the last 10 years has suggested that cannabis use can have serious consequences for people, such as the development of an enduring psychotic illness (12). Freeman and colleagues (11) conducted a double-blind study and found that THC produced psychological effects such as anxiety, paranoia, and a range of anomalous experiences such as sounds seeming louder, colours brighter, and time seeming distorted. Di Forti and colleagues (13) showed that people who carry a specific variant of the AKT1 gene should be particularly careful with using cannabis. The risk of psychosis among people with the specific variant of the AKT1 gene is seven times higher for those who use cannabis daily, compared to those who use it infrequently or not at all, however, people will not be aware that they carry the AKT1 gene, leading to an unknown risk.

Additionally, age of onset of psychosis may be altered when using cannabis. A meta-analysis conducted by Myles and colleagues (12) investigated the onset of age of psychosis for cannabis users. For cannabis users, onset of psychosis was 32 months earlier than for people who did not use cannabis. Results suggest that earlier onset psychosis is associated with cannabis use and is not the result of other variables that were examined which has been supported by numerous studies (14,15).

Cannabis use may also exacerbate the symptoms of psychosis. Schoeler et al. (8) conducted a meta-analysis to examine the effects of continued or discontinued cannabis use in patients with psychosis. When controlling for extraneous variables, continued cannabis users had a greater risk of relapse of psychosis, positive symptoms, and longer hospital admissions than

discontinued users. Schoeler et al. (8) concluded that discontinuing cannabis use was crucial to improve outcomes for patients with psychosis. The notion that cannabis use exacerbates symptoms of psychosis was supported in a multi-causal model, in which genetic vulnerability interacts with a precipitating agent to produce a disease outcome (16). However, as psychosis is a complex multi-causal phenomenon, it is difficult to conclusive prove that cannabis can cause early onset psychosis, and that cannabis can intensify symptoms.

Cannabis use and Depression

It has been suggested that recreational cannabis use can influence onset of depression and the symptoms of depression, and that depression increases the likelihood of future cannabis use (17). Patton examined the link between cannabis use and depression in a seven-wave cohort study that lasted six years. Results showed that daily cannabis use in young women was associated with a 500% increase in the risk of reporting depression or anxiety. Additionally, weekly, or frequent cannabis use was associated with a 200% increase in the risk of reporting depression or anxiety. This association persisted after adjustment for concurrent use of other substances, suggesting that heavy cannabis use may be a causal factor in depression and anxiety. However, teenage depression and anxiety did not predict future cannabis use which indicates that self-medication is unlikely to be the reason for the association. These findings were further supported by Lev-Ran et al. (18), who suggested that heavy cannabis use was associated with an increased risk of developing depression, and Troup et al. (10) who used event-related paradigms and found that participants who reported the highest levels of cannabis use showed the largest deficits for emotional processing. These findings suggest that cannabis use may exacerbate depressive symptoms.

The link between cannabis use and depression is highlighted further by research showing that cannabis use can influence suicidal ideation (19). Associations between cannabis use and suicidal ideation and unplanned suicide attempts remained significant after accounting for other drug use and comorbid psychiatric disorders. However, Borges, Bagge, and Orozco (20) refuted the notion that cannabis use may lead to suicidal ideation and stated that evidence found in previous studies should be considered unreliable due to the lack of measurement standardisation for measuring cannabis use and the lack of control for risk factors.

Cannabis use and Anxiety

Anxiety has extensive consequences for health, stress, emotional wellbeing, social functioning, self-esteem, and social inclusion (11). Because of this, it is important to establish the direction of the relationship between cannabis use and anxiety, as it could have wide implications for treatment options.

Previous studies have suggested that cannabis use precedes anxiety (9,21). In terms of the psychosis symptoms outlined above, there are people that would view some of these side effects as entertaining and enjoyable; however, this experience may come with unwanted side effects, such as anxiety. A review by Kedzior and colleagues (21) on cannabis use and affective disorders showed cannabis use was more often associated with later anxiety than anxiety was associated with future cannabis use. Despite this, some anxiety disorders preceded cannabis use, therefore, the empirical evidence suggested that cannabis use might be either an indicator or a consequence of affective mental health problems in the general population. However, the conclusion that there is a relationship between cannabis use and anxiety was disputed by Feingold, Weiser, Rehm, and Lev-Ran (22) who conducted a three-year prospective study to

explore the association and indicated that cannabis use was not associated with an increased risk of anxiety, and anxiety was not associated with future cannabis use.

Overall, the literature shows a complex relationship between (recreational) cannabis use and a range of psychiatric issues such as psychosis, depression, and anxiety. Many studies use a cross-sectional approach to show associations between cannabis use and psychiatric disorders; however, this may miss the importance of temporal order and the questions of 'which came first?' Temporal methods have recently been used in clinical areas such as depression and suicide attempts (23,24), showing how depression and suicidal behaviours develop. Therefore, the use of temporal methods, such as Behaviour Sequence Analysis, may help to clarify the relationship between cannabis and psychiatric disorders.

Behaviour Sequence Analysis

Behaviour Sequence Analysis (BSA) outlines the temporal connections between variables (behaviours, events, cognitions). BSA takes a systems approach[1] (25) to show how each variable contributes to the system as a whole, and the changes of the systems over time. In practical terms, it can show the temporal relationship between mental health and cannabis use. As well as this, BSA provides an additional level of information about behaviours that are observed that is not accessible to non-sequential analyses (26). BSA takes a sample of cases and produces a schematic map on which different pathways represent the commonest sequences of events that occur, linking, in this case, cannabis use with the development of mental illness.

[1] The Systems Approach is a way of combining parts of a system to understand how they work together. For example, if you want to understand how a heart works, do not take it out of the body – study it in the 'environment' it works in. In a similar way, in terms of the current study, to understand how recreational cannabis use affects individuals, we must attempt to study individuals in a 'normal' context, and take into account the entire system of variables that may influence recreational cannabis use and wellbeing. This is in contrast to laboratory studies that places individuals in a lab and studies them.

Behaviour Sequence Analysis is a three-stage method. First, a corpus of information (e.g., qualitative diary reports) are collected, and *parsed* into discrete behaviours, events, or cognitions. A coding scheme is then used to categorise each parsed behaviour, event, or cognition, such that similar behaviours are *categorised* together (e.g., *I took cannabis* and *I did some cannabis* are labelled as Category 'A'). In this way, a large corpus of qualitative information is reduced to a simple chain of category codes (e.g., A, B, C…*n*). Finally, the chains of categories are analysed to show the transitions between them. In Lag-one BSA, the simplest form of BSA, pairs of behaviours are analysed (25). The behaviour lists are analysed to identify which antecedent behaviour (e.g., 'A') is more likely to lead to which sequitur behaviour (e.g., 'B'). If the likelihood of one behaviour following another is above the level of statistical chance, these events are considered to show a sequential pattern. Transitions between behaviours can then be charted in a state transition diagram (25,27). BSA is a useful method for investigating sequential patterns between behaviours and events and has been used in previous research to examine behaviour patterns (28–31), alcohol use (32,33), drug addiction (34), and suicide (23,24).

Method

Sample

A sample of participants (N=61[2]) was gained via self-help forums and drug addiction forums online (accessed from a UK server and containing reports of individuals from United State of America and United Kingdom). Of the 61 participants, 10 were female, 32 were male

[2] There are currently no strict guidelines for determining appropriate sample size in BSA; therefore, the current sample size was selected as it is commensurate with other research that uses BSA in clinical groups (23, 24) and online samples (43).

and 19 did not specify their gender. Similarly, age and ethnicity of the participants was not specified. Most participants had personal experience of cannabis use and most participants had personal experience of mental health issues; however, some reports were second-hand accounts given by individuals closely affected by cannabis use. All second-hand accounts were evaluated in terms of knowledge and awareness of the issues, and were included to provide a more comprehensive overview (rather than simply taking a self-selecting sample of only those cannabis users who write about their experiences, we also wanted to gain accounts of those who had cannabis and mental health issues; but, did not write about it). The Research Ethics Committee at the University of Lincoln approved the current study.

Data

The data consisted of 61 descriptive, detailed accounts of individuals' experiences of cannabis use and mood disorders. Forums focusing on drug (recreational cannabis) use and individuals' life history and mood disorders were purposively sampled, within these forums searches through forum users' posts were then made to find accounts that met the following inclusion criteria: the first inclusion criterion was that data provided temporal accounts of the development of mental illness (either before or after cannabis use), as well as surrounding events and behaviours. Accounts required at least 3 distinct temporal points for the sequence analysis, as a minimum (25). Therefore, the data satisfied the minimum criterion, and were detailed enough to provide clear accounts of individuals' experiences.

Coding Scheme

Initially, an extensive literature search was conducted on research of cannabis use and mood disorders. This gave an initial list of behaviours that have previously been shown to be related to recreational cannabis use and mood disorders. To ensure an exhaustive list of behaviours, which is a prerequisite of BSA (35), the list was supplemented with additional codes identified in individuals' accounts, this resulted in a behaviour list of 73 behaviours. Essentially, as researchers read through the transcripts, if any behaviour occurred that was not already in the behaviour list, it was added *post hoc*, which ensured that all behaviours, events, and cognitions were included. To ensure that participants accounts were accurately coded, multiple researchers read the behaviour list and the translation (coding) process ensuring full agreement between codes and coding. Given the relatively straightforward nature of the statements and clear coding scheme, there were no ambiguous cases or categories. Back-translation[3] (28,36) was also used to recreate statements and showed that the coding scheme captured the essence of statements without loss of important sequential data.

Procedure

The study consisted of using statements and reports found in online self-help forums and drug addiction forums about cannabis use and life events. A behaviour list was used to code these events and behaviours, in the order in which individuals' suggested they occurred in their life history. The behaviour sequences were input into a BSA program in the program R (37), which ran a Chi-square analysis to find all the consecutive pairs of behaviour that occurred

[3] The back-translation process means that the final coded outcome "A→B→C→D" was turned back into actual descriptive behaviours. The back-translated account is then compared to the original statement from the forum and all researchers agreed on the accuracy of the coding and back-translation for accuracy of keeping essential information, without undue loss of meaning or facts. This is the standard way of conducting BSA research.

statistically above the level of chance and give standardised residual (SR) scores, which are a measure of the strength of difference between observed and expected values –which was calculated via the Chi-Square analysis. State transition diagrams were then created, linking the over-represented event pairs into coherent 'flow-diagrams' or maps, called *state transition diagrams*.

Statistical analysis

Initially, the data were screened to ensure all sequences were detailed and accurately coded. Sequences were then collated and entered into a statistical programme R (37) to calculate a lag-one sequence analysis. This means each event is considered in relation to the one immediately after it - that is after a 'lag' of one step. An example of a lag-one sequence is: a-b, or d-a, or c-b, where '-' means 'immediately followed by'. A lag-one analysis takes every possible pair of consecutive events, and identifies the pairs that occur too often to be a coincidence based on the raw frequency of the two events considered separately[4]. In the current study, for example, participants may report they ‘got into a relationship’ (which is an antecedent, ‘A’ for example) and then ‘continued smoking cannabis’ (which is a sequitur, ‘B’ for example).

Results

Frequency Analysis

Before BSA, frequencies of individual behaviours are calculated. The frequency analysis (see Table 1) showed several high frequency behaviours: *Stopped smoking weed* (n = 63) *Smoked*

[4] There are higher order sequence analyses (e.g., [ab]→c, [bc]→d); however, lag-one is the standard approach to BSA.

weed everyday (n = 52), *Continued smoking weed* (n = 51), *Smoked weed* (n = 42), *Started doing other drugs* (n = 35), and S*tarted drinking alcohol* (n = 30). *Depression* and *Became paranoid* was reported 23 times. Frequencies can be compared to previous research into prevalence rates; however, BSA goes further to show the associations between pairs of behaviours.

--TABLE 1 ABOUT HERE, PLEASE--

Initially, the programme ran a Chi-square analysis on the sequence pairs to find all behaviour pairs that occur statistically above the level of chance. In the current study, Chi-square analyses resulted in 134 behaviour pairs occurring above the level of chance, which indicates a limitation of focusing on *p* value statistical testing (25,28). As significance testing alone is not efficient for the development of clear state transition diagrams in BSA, using a more rigorous cut-off criterion has previously been suggested (33)[5]. Therefore, to make the analysis comprehensible, only pairs of behaviours with high frequency (n) and standardised residuals (SR) are shown in the current results[6]. For the first analysis, behaviour pairs with a frequency of three or more were selected as a stringent criterion. However, for the second analysis, behaviour pairs with a frequency of two or more were selected as a stringent criterion. This is because these cut-off points generated a clear and logical diagram with complete start-to-finish chains. Setting

[5] The state transition diagram is a simplified representation of the entire BSA. If all statistically significant transitions were included in the diagram, it would not be readable owing to the complexity. Therefore, the complete list of transitions can be seen in the transition frequency matrix, and only those with higher standardized residual scores are included in the diagram. This is a standard approach in BSA research.

[6] Full results including the entire transition frequency matrix can be obtained from the correspondence author, on request.

the criteria lower lead to overly complicated, illegible diagrams, and setting the cut-off higher lead to a break-down of the chains, creating multiple 'islands' of behaviours[7].

Two diagrams were developed, based on the current results. First, a state transition diagram (see Figure 1) was developed to show pairs of behaviours that occurred when only including data from participants who used cannabis prior to any mental health issues. A second state transition diagram (see Figure 2) was developed to show pairs of behaviours that occurred when participants suggested they experienced some mood disorder symptoms prior to using cannabis. Behaviours are colour coded according to frequency and standard residuals are indicated through the thickness of the linking arrows

Understanding the state transition diagram

As a first-order sequence analysis was used, the state transition diagram only reliably indicates behaviour pairs. When a diagram shows A→B→C for instance, it should be remembered that this is based on observations of A→B and B→C, rather than A→B→C per se. The state transition diagram shows chains that appear to abruptly end (e.g. addict in the family). It is important to note that all transitions between pairs of behaviours in the diagram were significant; however, as the cut-off point of frequency 3 was chosen, some routes stop before the end point, such as smoked weed on special occasions. Breaks in the chain do not indicate the sequence of behaviours ended at this point, it simply means this chain did not have a frequently occurring sequitur behaviour, on the criteria of 3 or more occasions. Finally, islands of

[7] The rationale for using these cut-offs is to solve two problems: (1) to avoid filling the diagram with event pairs that only occur as often as they would by chance (i.e., statistical noise); and (2) to avoid including pairs that are above chance but only because the component events are so rare that any occurrence seems remarkable, however infrequent

behaviours occurred, such as *Did not feel good enough* and *Low self-esteem*. This occurs as some behaviours may strongly link to each other; but, may not systematically link to any other behaviours in the diagram. Using the previous example, the link between *Did not feel good enough* and *Low self-esteem* are linked; however, there is no clear antecedent connection or sequitur connection to the rest of the diagram that occur at a frequency of three or more.

Cannabis use preceding mood disorders

The first analysis was of participants who had reported recreational cannabis use preceding mood disorders (N= 44). The first thing to notice is that there is far more variety in the second state transition diagram than there is for the first state transition diagram, which is partly due to a cut-off frequency of 2 instead of 3. As previously discussed, this is because a cut-off point of 2 created the most coherent diagram. Despite this, the most common start and end points are the same as the first state transition diagram.

--FIGURE 1 ABOUT HERE, PLEASE—

Within the sequences, there is no clear path between start and end of timelines. However, the most frequently occurring start points are happy child (SR=9.78, n=8), addict in the family (SR=9.78, n=8), and smoke weed (SR= 7.11, n=12). This suggests that there are a wide variety of motivations for why people may use cannabis. The most frequently occurring end points are stopping smoking cannabis (SR=13.19, n=24) and suicide (SR=9.79, n=7).

The most frequently occurring behaviour pair sequences are as follows: stopped smoking weed and End (SR=13.19, n=24), Start and smoked weed (SR=7.11, n=12), I used marijuana anonymous/ 12 step programme and stopped smoking weed (SR=9.34, n=9), rehabilitation programme and continued smoking weed (SR=7.32, n=8), Start and addict in the family (SR=9.78, n=8), Start and happy child (SR=9.78, n=8), and suicide and End (SR=9.79, n=7).

As well as this, Psychosis (n=7) occurs and has two occurring sequitur behaviours: hearing voices (SR=10.2, n=3) and psychiatric ward admittance (SR=6.3, n=2), which do not appear in the second state transition diagram.

Mood disorders preceding cannabis use

In the second state transition diagram, data were used only from participants who had reported experience of previous mental health issues before smoking cannabis (N=17), which was a smaller data set than the data sets used for the first state transition diagram (Figure 1) and second state transition diagrams (Figure 2). As previously discussed, a cut-off point of 2 was used as it provided the clearest diagram that had pathways from start to finish.

--FIGURE 2 ABOUT HERE, PLEASE—

Within the sequences, there is no clear path between start and end of response. However, the most frequently occurring start points are anxiety (SR=2.75, n=2), depression (SR=1.86, n=2)

and popular[8] (SR= 5.09, n=2), however, popular had a sequitur behaviour of unpopular (SR=9.87, n=2). This could suggest that participants used cannabis as a coping strategy for emotional difficulties. The most frequently occurring end points are stopping smoking cannabis (SR=12.11, n=13) and anxiety (SR=2.75, n=2).

The most frequently occurring behaviour pair sequences are as follows: stopped smoking weed and End (SR=12.11, n=13), I used marijuana anonymous/ 12 step programme and stopped smoking weed (SR=12.97, n=12), smoked weed every day and I isolated myself/lost friends (SR=3.97, n=4), smoked weed and smoked weed every day (SR=4.21, n=4), smoked weed every day and left school- uncompleted (SR=6.78, n=3), and suicidal and suicidal (SR=8, n=3).

Most common mental illnesses were depression (n=13) and anxiety (n=8), which supports previous research (Lev-Ran et al., 2014; Freeman et al., 2014). Depression had multiple antecedent behaviours, suggesting that there are varied reasons for the onset of depression. However, sequitur behaviours included arrested by police (SR=7.39, n=2) and suicidal (SR=3.6, n=2), suggesting that cannabis use may not be a useful coping strategy for depression. Anxiety had antecedent behaviours of start (SR=2.75, n=2), and sequitur behaviours of smoked weed (SR=3.68, n=2) and end (SR=2.75, n=2), suggesting that cannabis may be used as a coping strategy for anxiety.

Discussion

The aim of the current study was to investigate the relationship between recreational cannabis use and mental illness using BSA. The findings support the notion that cannabis may be an antecedent and a consequence of mood disorders (21). Corresponding with previous results,

[8] This refers to whether the individual stated they were popular or unpopular

the current study findings suggest that cannabis use precedes psychosis. As discussed, due to the nature of the data collection method used in the current study, family medical history was not known and so it cannot be conclusively proven that cannabis use causes the onset of psychosis. Despite this, it can be concluded that cannabis use may be a contributing factor to the onset of psychosis. As individuals will not know if they are genetically predisposed to develop psychosis, they will not know if they are susceptible to the effects of cannabis use. Thus, people should be warned that the risk of an individual succumbing to psychosis as a side effect of cannabis is unknown, and so cannabis should be used with caution, and should be avoided if there is a family history of psychosis.

The current findings also suggest that cannabis may be an indicator or a consequence of depression. In the first state transition diagrams, cannabis use preceded depression. However, in the second state transition diagram depression preceded cannabis use for some participants, which could suggest that some people with depression self-medicate with cannabis as a coping mechanism. Despite this, depressive symptoms did not improve when cannabis was used, in fact, cannabis use aggravated depressive symptoms. In addition, a common sequitur behaviour of depression was suicidal behaviour in both state transition diagrams. Owing to the current findings, it is crucial to ensure people are informed about the aggravating effects of cannabis on depression, to decrease the risk of depression and suicidal behaviour. Many people may use cannabis to self-medicate; however, it can be concluded that it is not always beneficial for people to self-medicate with cannabis to help mental health issues, as cannabis may exacerbate mental illnesses such as anxiety and depression

The current study suggest that anxiety may precede cannabis use, as participants used cannabis to self-medicate and relax. Contrary to participants' desired outcomes, however,

cannabis prolonged anxiety symptoms even after participants had stopped using cannabis, which would indicate that cannabis is not effective in treating anxiety and may exacerbate anxiety symptoms. As outlined, some recreational cannabis users may enjoy the side-effects of cannabis use; however, the psychosis symptoms associated with cannabis may lead to increased anxiety in others (11, 13).

Previous research has suggested that cannabis is a promising treatment option for physical illnesses (4,5). Despite this, the current findings suggest that cannabis can lead to a range of mental health disorders, such as depression, anxiety, and psychosis, even when participants had no known history of mental illness. If cannabis is used in treatment, it is recommended that efforts should be made to regularly assess individuals' mental states to ensure further complications do not arise, and people with an individual history of depression or anxiety, and people with a family history of psychosis, should avoid cannabis use.

Similarly, previous research has suggested that cannabis may be an effective treatment for mental illnesses, such as post-traumatic stress disorder (PTSD) (41) and attention deficit hyperactivity disorder (ADHD) (42). However, the current study findings suggest that using cannabis to treat mental illnesses may create more problems than it solves due to side effects found in the current study, such as anxiety, depression, and psychosis.

Another practical consideration arising from the current study concerns potential treatments for people who are addicted to cannabis, or who abuse cannabis. The current study suggests that rehabilitation programmes are not as effective as 12-step programmes, such as Marijuana Anonymous. Rehabilitation programmes in the current study were shown to lead to continued smoking of weed; however, use of marijuana anonymous/ 12 step programme had a sequential behaviour of stopping smoking weed.

One of the limitations of the current study includes the method of data collection. The study consisted of using statements and reports found in self-help forums and drug addiction forums about cannabis use and life events. Due to the nature of the data collection method used, there is incomplete data, such as the ages or gender of participants, which may impact results. However, a strength of this approach is that indivduals can answer more openly and freely about their life history. Future studies should use interviews as a method of data collection to gather more detailed information. Alongside this interview approach, future studies should 'time stamp' data in order to understand the time-series development of mental health issues. A further strength of the current study is the use of state transition diagrams, which are easy to understand for professionals and non-professionals, which means that findings can be understood and utilised by people in many different fields of research, careers, and ages.

Conclusion

In conclusion, the current study examined the relationship between recreational cannabis use and mental health using BSA. The current study has demonstrated that BSA is a promising research method that enables the exploration of complex social processes and behaviours, such as cannabis use and mental health, and enables a clear view of the relationship between multiple variables. BSA provided a clear sequence of events that lead people to use cannabis, and how mental illnesses relate to cannabis use. Cannabis use may lead to various mental illnesses, such as depression, paranoia, and psychosis, whereas anxiety may lead to cannabis use in an effort to self-medicate and aid relaxation. Practical considerations of the current study findings have been

discussed, including; using cannabis as a treatment for physical illnesses, treatment for mental illnesses, treatment for cannabis users, and lowering crime rate. Considering the increasing levels of cannabis use, it is advised that measures to decrease cannabis use, such as education and 12-step programmes, should be researched and employed, which will lower crime rate, lower suicide rate, and make society, and individuals, healthier.

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